

1 Test Sample Description:

Product Name: SecureKey Fob

Functional Description: The security key fob is used for a secondary immobilizer authentication device that communicates via a paired and bonded communication channel with the secondary immobilizer in the vehicle.

Power supply: 3VDC Battery

BLE:

Frequency Range: 2402 – 2480 MHz

Mode of operation: DTS

Antenna Description: 2.4GHz Mini Antenna, SMT P/N 2450AT18B100, Peak Gain:0.5(dBi typ.)

Transmitter Category: Portable (A transmitting device designed to be used in other than fixed locations and to generally be used in such a way that the RF source's radiating structure(s) is/are within 20 centimeters of the body of the user.)

Reference Standards

§ 1.1310: Radiofrequency radiation exposure limits.

§ 2.1093: Radiofrequency radiation exposure evaluation: portable devices.

§ 1.1307(b)(3)(i)(b): For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section)

KDB 447498 D01 General RF Exposure Guidance v06

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2 Determination of exemption.

(i) For single RF sources (*i.e.*, any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section): A single RF source is exempt if:

(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

(B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by:

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the separation distance (cm);

(C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

Table 1 to § 1.1307(b)(3)(i)(C)- Single RF Sources Subject to Routine Environmental Evaluation				
RF Source frequency (MHz)		Minimum Distance		Threshold ERP (watts)
FL	FH	$\lambda L/2\pi$	$\lambda H/2\pi$	
0.3	1.34	159 m	35.6m	1,920 R ² .
1.34	30	35.6 m	1.6m	3,450 R ² /f ² .
30	300	1.6 m	0.159 m	3.83 R ² .
300	1,500	0.159 m	0.0318 m	0.0128 R ² f.
1,500	100,000	0.0318 m	0.0005 m	19.2R ² .

R= minimum separation distance in meter

f= frequency in MHz

3 Calculation:

Using equation i(B) as per determination of exemption, minimum antenna separation distance of 0.5 cm from the human body, and maximum Tx frequency is 2480 MHz.

$$ERP_{20cm} \text{ (mW)} = 3060 \text{ (Frequencies = } 1.5\text{GHz} \leq f \leq 6 \text{ GHz)}$$

$$ERP_{20cm} = 3060 \text{ mW)}$$

$$x = -\log_{10} (60 / ERP_{20cm} \sqrt{f}) \text{ (f in GHz)}$$

$$x = -\log_{10} (60 / 3060 \sqrt{2.480})$$

$$x = 1.904796017$$

Calculation for **5mm(0.5cm) separation distance**

$$P_{th} \text{ (mW)} = ERP_{20cm} (d / 20 \text{ cm})^x$$

$$P_{th} \text{ (mW)} = 3060 (0.5\text{cm} / 20 \text{ cm})^{1.904796017}$$

$$P_{th} = 2.717214578 \text{ (mW)}$$

$$P_{th} = 2.72 \text{ (mW)}$$

$$P_{th} = 4.3457 \text{ (dBm)}$$

The Security Key Fob, antenna peak gain is 0.5 dBi, and therefore,

$$\text{Antenna Gain dBd} = \text{dBi} - 2.15$$

$$\text{dBd} = 0.5 - 2.15$$

$$\text{dBd (Gain)} = -1.65$$

$$\text{ERP} = \text{Maximum average antenna port conducted Power (dBm)} + (-1.65)\text{dBd}$$

$$\text{ERP} = -1.48 + (-1.65) = -3.13 \text{ dBm}$$

So

$$\text{ERP} \leq P_{th}$$

$$\text{ERP} \leq 4.3457 \text{ dBm}$$

TX (Mode)	Frequency (MHz)	Max Conducted RF Output (measured) 100% Duty Cycle (dBm)	Max. antenna gain Peak (dBi)	Max. antenna gain (dBd)	ERP 100% Duty Cycle (dBm)	ERP 100% Duty Cycle (mW)	ERP Exemption limit ≤ 5mmSeparation distance
BLE	2402	-1.48	0.5	-1.65	-3.13	0.49	2.72 mW = 4.3457 dBm
	2440	-1.54	0.5	-1.65	-3.19	0.48	
	2480	-2.29	0.5	-1.65	-3.94	0.404	
As per BLE IC data Sheet absolute max. output power		4	0.5	-1.65	2.85	1.93	

According to the KDB447498 4.3.1(a)

For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR, where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

$[1.93\text{mW} / 5\text{mm}] \times [\sqrt{(2.480\text{GHz})}]$	$\leq$	3.0 for 1-g SAR
0.607873407	$\leq$	3.0 for 1-g SAR
0.61	$\leq$	3.0 for 1-g SAR

5 Conclusion:

EUT meet SAR exemption limit